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Entladungsröhre

Tube à décharge

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(73) Proprietors:
- **TOKYO DENSOKU KABUSHIKI KAISHA**
Kamakura-shi, Kanagawa-ken (JP)
- **NORITAKE CO., LIMITED**
Nishi-ku, Nagoya 451 (JP)

(72) Inventor: **Nieda, Yoriyuki**
Kamakura-shi (JP)

(74) Representative: **Humphreys, Ceris Anne et al**
London WC1V 7LH (GB)

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- **Lamps and Lighting, S.T. Henderson and A.M. Marsden Thorn Lighting Ltd. 1972, ISBN 0713132671 pages 146-7.**

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D scription

This invention relates generally to a discharge tube, and more particularly to the type of discharge tube which includes a pair of electrode devices provided in a discharge space in opposed relation to each other, each of the electrode devices being constituted by an arc discharge electrode and a glow discharge electrode.

The Applicant of the present invention has proposed, in Japanese Patent Application Nos. 1-5753 and 2-124177, discharge tubes of the type in which a pair of electrode devices, each composed of an arc discharge electrode and a glow discharge electrode, are disposed in a discharge space in opposed relation to each other. These discharge tubes are used as a back light lamp for a liquid crystal display device, an illumination fluorescent lamp, or the like. As described above, each of the pair of opposed electrode devices of the discharge tube comprises an arc discharge electrode and a glow discharge electrode, and the two electrodes are disposed adjacent to each other. Thanks to the synergistic effect of the arc discharge and the glow discharge, a discharge of an ultra-high brightness can be obtained in a stable manner, so that a discharge tube of an ultra-high brightness can be obtained. And besides, electron-radiating substances, vaporized and emitted in a scattered manner from the arc discharge electrode, are captured by the glow discharge electrode, and since the electron-radiating substances thus captured can be again used for the electron radiation, there can be obtained a discharge tube of an extremely long service life.

In a manual entitled "Lamps and Lighting", General Editors S. T. Henderson and A. M. Marsden, it has been suggested that electrodes be formed of tungsten containing 0.5% to 3.0% thoria, particularly in highly rated lamps where an emitter coating would be sputtered off.

Recently, there has been provided an arc discharge electrode which is formed by mixing an electronradiating substance, such as barium, lanthanum boride and cesium, with powder of tungsten, and then by pressmolding or compacting this mixture together with a lead wire, using a mold, and subsequently by sintering this compact.

It is an object of this invention to provide a discharge tube which has the above-mentioned sintered arc discharge electrode and has a long service life.

According to the present invention, there is provided a discharge tube comprising a tubular body having an interior which defines a discharge space; and a pair of electrode devices mounted in said discharge space in opposition to each other, each of said pair of electrode devices comprising an arc discharge electrode and a cup-shaped glow discharge electrode, and an electron-emitting substance associated with said arc discharge electrode, characterised in that said arc discharge electrode is composed of a cylindrical sintered body containing said electron-emitting substance therein, and said glow discharge electrode coaxially surrounds at least a part of said cylindrical sintered body, said glow discharge electrode being formed of a pipe made of aluminum, nickel or iron and in that said cup-shaped glow discharge electrode has a cylindrical shape and forms a uniformly thin annular gap with said arc discharge electrode.

In the present invention, the vaporization and emission of the electron-radiating substance from the arc discharge electrode can be reduced, as compared with the conventional discharge tube in which the surface of the arc discharge electrode is coated with such an electron-radiating substance. Therefore, the lifetime of the arc discharge electrode is prolonged, and this further prolongs the service life of the discharge tube.

Said sintered body may be integrally molded at its end with a lead wire which extends through a proximal closed end part of said glow discharge electrode and which is supported to one end of said tubular body. Since the lead wire can be integrally moulded in the arc discharge electrode, the electrode device can be directly mounted on the discharge tube, and this facilitates the manufacture of the discharge tube.

A filament coil electrode may be connected to a distal end of said arc discharge electrode.

Said sintered body may be projected rearward from said glow discharge electrode through a proximal closed end part of said glow discharge electrode.

A getter member may be provided adjacent to an outer periphery of said glow discharge electrode.

By way of example embodiments of the invention will now be described with reference to the accompanying drawings, of which:

Fig. 1 is a longitudinal cross-sectional view of a first embodiment of a discharge tube of the present invention;

Fig. 2 is a schematic perspective view of an electrode device shown in Fig. 1;

Fig. 3 is a perspective view of a sintered arc discharge electrode shown in Fig. 2;

Fig. 4 is a partly-broken, perspective view of a glow discharge electrode shown in Fig. 2;

Fig. 5 is a perspective view of a modified glow discharge electrode;

Fig. 6 is a partly-broken, perspective view of a modified electrode device used in the discharge tube of Fig. 1;

Fig. 7 is a partly-broken, perspective view of an electrode device used in a test;

Fig. 8 is a partly-broken, perspective view of a further embodiment of the invention.

Preferred embodiments of the present invention will now be described with reference to the drawings.

Fig. 1 is a longitudinal cross-sectional view of a discharge tube. This discharge tube comprises a glass tube body 1 whose inner surface is coated with a fluorescent material 2. Two electrode devices 4 are mounted within the tube body 1, and are positioned respectively at the opposite end portions of the tube body 1 by lead wires 3 extending respectively through the opposite end walls of the tube body 1. The electrode devices 4 in a pair are disposed in an opposed relation to each other. A mixture gas of argon and mercury is sealed in the discharge tube for the purpose of discharging.

As shown in Fig. 2, each of the electrode devices 4 comprises a generally cup-shaped glow discharge electrode 5 formed of a pipe made of aluminium, nickel or iron, and an arc discharge electrode 6 which is composed of a sintered metal body and is received within the glow discharge electrode 5 coaxially therewith. The arc discharge electrode 6 is supported by the lead wire 3 which extends through a through hole, which is extended through the closed end portion of the cup-shaped glow discharge electrode 5, and fixedly secured thereto by pressing or compressing.

Fig. 3 is a perspective view of the arc discharge electrode 6. For forming the arc discharge electrode 6, barium is mixed with powder of tungsten, and by the use of a mold, this powder mixture is pressmolded or compacted into a cylindrical shape, with one end portion of the lead wire 3 being embedded in one end portion of this cylindrical compact. Then, this cylindrical compact is sintered to provide the arc discharge electrode 6. Cesium, lanthanum boride and other suitable materials may be added to the above mixture.

Fig. 4 shows the glow discharge electrode 5. The through hole is formed axially through the closed end portion of the cup-shaped glow discharge electrode 5. As will be appreciated from Fig. 2, after the lead wire 3 is passed through this through hole, the closed end portion of the glow discharge electrode 5 is compressed or pressed radially inwardly, so that the arc discharge electrode 6 is held within the cup-shaped glow discharge electrode 5 coaxially therewith.

As shown in Fig. 5, a getter member 11 may be provided adjacent to the outer periphery of the glow discharge electrode 5. In this case, the rear end portion of the getter member 11 is bent and welded to the lead wire 3 extending through the through hole. Preferably, a zirconiummercury getter should be used as the getter member 11. If such a getter is used, there is no need to seal mercury in the discharge tube, since mercury is already contained in the getter.

Fig. 6 shows a modified form of the above embodiment.

In this embodiment, a filament coil electrode 6a is further connected to a distal end of an arc discharge electrode 6 of an electrode device 4. With the sintered arc discharge electrode 6 having no such filament coil electrode 6a, it takes 1 to 2 minutes before the normal discharge is obtained after turning on the discharge tube; however, with the construction of Fig. 6, the normal discharge can be obtained in about 10 to 20 seconds after turning on the discharge tube. More specifically, the filament coil electrode 6a first begins an arc discharge, and the sintered arc discharge electrode 6 is heated by the heat generated by this arc discharge, so that the normal discharge condition can be soon obtained. And besides, since the discharge of the filament coil electrode 6a is added, the brightness is enhanced.

The filament coil electrode 6a is formed by coating an active oxide onto the surface of a coil and then by hardening this coil.

The above embodiments are examples of cold--cathode fluorescent discharge tubes. Examples of hot-cathode fluorescent discharge tubes will be described below.

Example 1

Results of a test of a discharge tube according to the present invention will be described with reference to Fig. 7. The specifications of this discharge tube are as follows:

Oscillation frequency: 50 kHz

Oscillation voltage: 700 v (effective value)

Sealed gas:

Argon: 6.67 x 10^3Pa (50 torr)

Mercury: 5 mg

Outer diameter of glass tube: 6.5 mm
(thickness: 0.5 mm)

Length of glass tube: 250 mm

Fluorescent material: triple-wavelength fluorescent material (white color)

Atmosphere temperature: 20 deg. C

Opposed electrodes (see Fig. 8):

Outer diameter (D1) of glow discharge electrode: 4.5 mm

Inner diameter (d1) of glow discharge electrode: 3.5 mm

Overall length (L1) of glow discharge electrode: 4.5 mm
(Effective length: 3.5 mm)

Outer diameter (D2) of arc discharge electrode: 2.5 mm

Length (L2) of arc discharge electrode: 2.0 mm

Distance (DIS) between the distal end of arc discharge electrode and the end of the tube: 7.0 mm

Outer diameter (Ds) of lead wire: 1.5 mm

The results of the test are as follows:

Discharge current: 16 mA (effective value)

Brightness of discharge tube: 30,000 nit

Lifetime: 20,000 hr

The reason for the achievement of the above ultra-high brightness and ultra-long lifetime will be described. A blackening phenomenon caused by the electron radiating substance which is evaporated by electron and ion impacts develops in the cup-shaped electrode, and this substance still exhibits the function of electron radiation. Therefore, the blackening of the glass tube was prevented so that the lifetime of the discharge tube can be prolonged. Also, the glow discharge and the arc discharge occur at the same time, and therefore the ultra-high brightness can be obtained by the synergistic effect of these two discharges.

Fig. 8 shows a further embodiment of the invention.

In the above-mentioned embodiment, the arc discharge electrode 6 is received in the cup-shaped glow discharge electrode 5. During the manufacture of the discharge tube, in the evacuation step (final stage) of creating vacuum (1.33×10^{-4} to 1.33×10^{-6} Pa) (10^{-6} to 10^{-8} torr) in the discharge tube, in order to prevent a flickering of the emitted light (that is, to stabilize the discharge), the electrode device is heated by a bombarder to 900 to 1,000°C so as to remove dirt and harmful gases on the surface of the electrode. At this time, the arc discharge electrode 6 is likely to be hindered by the cup-shaped glow discharge electrode 5 from being sufficiently heated. As a result, in some cases, dirt and harmful gases may not be satisfactorily removed from the electrode 6.

The electrode device shown in Fig. 8 is analogous in structure to the electrode device of Fig. 2, but differs therefrom in that an arc discharge electrode 6a is projected by a distance of about 2 mm from a rear end of a glow discharge electrode 5. With this arrangement, during the above heating, the heat is propagated from the projected rear end portion of the arc discharge electrode 6a toward its distal end received within the cup-shaped glow discharge electrode 5, so that the whole of the arc discharge electrode 6a can be sufficiently heated rapidly, thus overcoming the above problem with the manufacture. However, in this case, it is necessary that the amount of radiation of electrons from the arc discharge electrode 6a should be determined to be greater than the amount of radiation of electrons from the glow discharge electrode 5. In this case, it is preferred that a Dumet wire (a trade mark) should be used as a lead wire.

Example 2

A test of a discharge tube as shown in Fig. 1 and incorporating the electrode devices of Fig. 8 was carried out. The specifications of this discharge tube are as follows:

Oscillation frequency: 50 kHz

Oscillation voltage: 2,500 v (peak value)

Sealed gas:

Argon: 9.33×10^3 Pa (70 torr)

Mercury: 5 mg

Outer diameter of glass tube: 5.8 mm
(thickness: 0.5 mm)

Length of glass tube: 260 mm

Fluorescent material: triple-wavelength fluorescent material (white color)
6000 K (Kelvin)

Atmosphere temperature: 20 deg. C

Opposed electrodes (see Fig. 8):

Outer diameter of arc discharge electrode: 1.5 mm

Length of that portion of arc discharge electrode received in glow discharge electrode: 2.0 mm

Length of the projected portion of arc discharge electrode: 2.0 mm

The results of the test are as follows:

Discharge current: 14 mA (effective value)

Brightness of discharge tube: 28,000 nit

Life time (reduction of brightness by half): 20,000 hr

With the above constructions, there can be manu-

factured discharge tubes which are high in mass-productivity, and inexpensive, and have good discharge characteristics, and are stable in operation.

A further improved effect can be obtained by coating an electron-radiating substance, such as barium, to either the surface of the arc discharge electrode 6a or this surface and the inner surface of the glow discharge electrode 5. By doing so, the brightness of the discharge tube is further improved.

This embodiment is suitable for a hot-cathode fluorescent discharge tube.

As described above, in the discharge tube comprising the pair of opposed electrode devices each including the arc discharge electrode and the glow discharge electrode, since the arc discharge electrode composed of the sintered body containing the active oxide is used, the service life of the discharge tube is further prolonged, and the discharge tube is highly resistant to vibration and impact. And besides, since the arc discharge electrode can be molded and sintered integrally with the lead wire, the assembling and manufacture of the discharge tube can be carried out easily.

Claims

1. A discharge tube comprising a tubular body (1) having an interior which defines a discharge space; and a pair of electrode devices (4) mounted in said discharge space in opposition to each other, each of said pair of electrode devices (4) comprising an arc discharge electrode (6) and a cup-shaped glow discharge electrode (5), and an electron-emitting substance associated with said arc discharge electrode (6), characterised in that said arc discharge electrode (6) is composed of a cylindrical sintered body containing said electron-emitting substance therein, and said glow discharge electrode (5) coaxially surrounds at least a part of said cylindrical sintered body, said glow discharge electrode (5) being formed of a pipe made of aluminum, nickel or iron and in that said cup-shaped glow discharge electrode has a cylindrical shape and forms a uniformly thin annular gap with said arc discharge electrode.

2. A discharge tube according to claim 1, wherein said sintered body (6) is integrally molded at its end with a lead wire (3) which extends through a proximal closed end part of said glow discharge electrode (5) and which is supported to one end of said tubular body (1).

3. A discharge tube according to claim 1, wherein a filament coil electrode (6a) is connected to a distal end of said arc discharge electrode.

4. A discharge tube according to claim 1, wherein said sintered body (6) is projected rearward from said glow discharge electrode through a proximal closed end part of said glow discharge electrode.

5. A discharge tube according to claim 1, wherein a getter member (11) is provided adjacent to an outer periphery of said glow discharge electrode.

Patentansprüche

1. Entladungsröhre mit einem röhrenförmigen Körper (1) mit einem Innenbereich, der einen Entladungsraum definiert, und einem Paar von Elektrodenvorrichtungen (4), die in dem Entladungsraum gegenüber zueinander montiert sind, wobei jede Vorrichtung des Paares von Elektrodenvorrichtungen (4) eine Bogenentladungselektrode (6) und eine schalenförmige Glimmentladungselektrode (5) aufweist und eine elektronenemittierende Substanz der Bogenentladungselektrode (6) zugeordnet ist, dadurch gekennzeichnet, daß die Bogenentladungselektrode (6) aus einem zylindrischen gesinterten Körper zusammengesetzt ist, der darin die elektronenemittierende Substanz enthält, und die Glimmentladungselektrode (5) koaxial wenigstens einen Teil des zylindrischen gesinterten Körpers umgibt, wobei die Glimmentladungselektrode (5) aus einem Rohr gebildet ist, das aus Aluminium, Nickel oder Eisen hergestellt ist, und daß die schalenförmige Glimmentladungselektrode eine zylindrische Gestalt hat und einen gleichmäßig dünnen ringförmigen Spalt mit der Bogenentladungselektrode bildet.

2. Entladungsröhre nach Anspruch 1, bei der der gesinterte Körper (6) einheitlich an seinem Ende mit einem Leiterdraht (7) geformt ist, der sich durch einen proximalen geschlossenen Endteil der Glimmentladungselektrode (5) erstreckt und der an einem Ende des röhrenförmigen Körpers (1) gelagert ist.

3. Entladungsröhre nach Anspruch 1, bei der eine Fadenwindungselektrode (6a) mit einem distalen Ende der Bogenentladungselektrode verbunden ist.

4. Entladungsröhre nach Anspruch 1, bei der der gesinterte Körper (6) rückwärts von der Glimmentladungselektrode durch einen proximalen geschlossenen Endteil der Glimmentladungselektrode vorspringt.

5. Entladungsröhre nach Anspruch 1, bei der ein Getterglied (11) neben einem Außenumfang der Glimmentladungselektrode vorgesehen ist.

R vendications

1. Tub à décharge comprenant un corps tubulaire (1) ayant un espace intérieur qui définit un espace de décharge, et deux dispositifs à électrodes (4) montés dans ledit espace de décharge en regard l'un de l'autre, chacun desdits deux dispositifs à électrodes (4) comprenant une électrode de décharge en arc (6) et une électrode de décharge luminescente (5) en forme de coupelle, ainsi qu'une substance émettrice d'électrons associées à ladite électrode de décharge en arc (6), caractérisé en ce que ladite électrode de décharge en arc (6) est composée d'un corps fritté cylindrique contenant ladite substance émettrice d'électrons, en ce que ladite électrode de décharge luminescente (5) entoure coaxialement au moins une partie dudit corps fritté cylindrique, ladite électrode de décharge luminescente (5) étant formée d'un tube constitué d'aluminium, de nickel ou de fer, et en ce que ladite électrode de décharge luminescente (5) en forme de coupelle a une forme cylindrique et constitue un espace annulaire uniformément mince avec ladite électrode de décharge en arc.

2. Tube à décharge selon la revendication 1, dans lequel ledit corps fritté (6) est moulé d'une pièce, à son extrémité, avec un fil conducteur (3) qui s'étend à travers une partie terminale fermée proximale de ladite électrode de décharge luminescente (5) et qui est supporté à une extrémité dudit corps tubulaire (1).

3. Tube à décharge selon la revendication 1, dans lequel une électrode en serpentin filamentaire (6a) est connectée à une extrémité distale de ladite électrode de décharge en arc.

4. Tube à décharge selon la revendication 1, dans lequel ledit corps fritté (6) fait saillie vers l'arrière de ladite électrode de décharge luminescente à travers une partie terminale fermée proximale de ladite électrode de décharge luminescente.

5. Tube à décharge selon la revendication 1, dans lequel un élément de getter (11) est disposé au voisinage de la périphérie externe de ladite électrode de décharge luminescente.

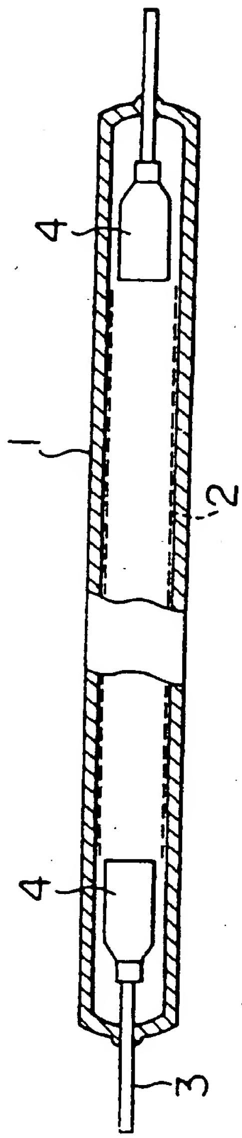

FIG. 1

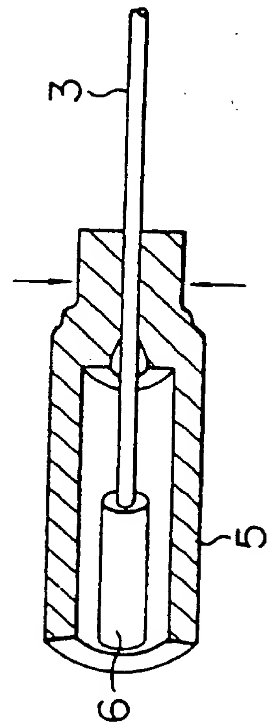

FIG. 2

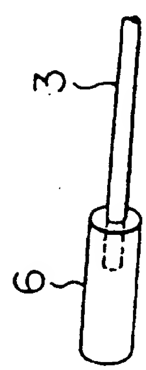

FIG. 3

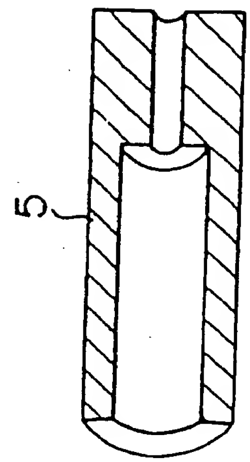

FIG. 4

FIG. 5

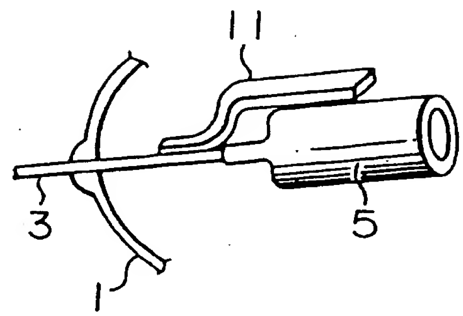

FIG. 6

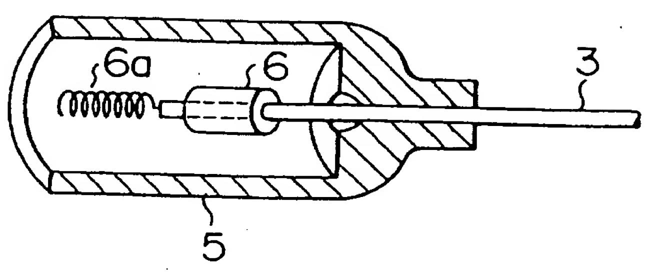

FIG. 7

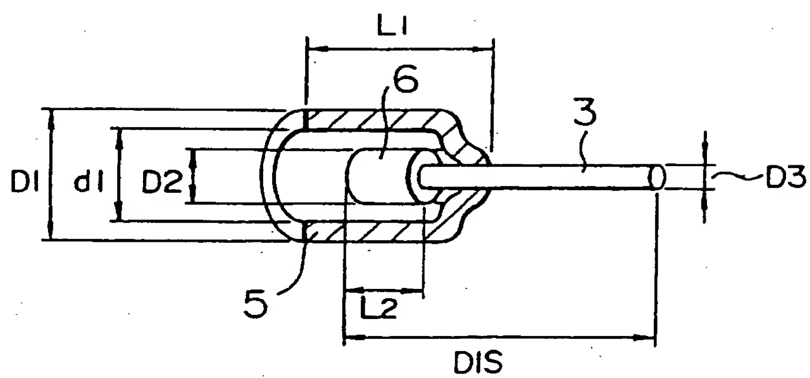

FIG. 8